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Evaluation of Bacteriological Quality of Drinking Water in the City Center of Tunceli, Turkey

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The aim of this study was to evaluate the bacteriological contamination of drinking water in Tunceli, Turkey. For this purpose, the presence of total coliforms, *Escherichia coli*, and Enterococci was investigated at ten water sampling stations in the Tunceli province. The microbiological dataset of the ten stations were obtained from the Health Directorate of Tunceli for this study. Detection of *E. coli* and total coliform was performed using the membrane filtration method, Turkish Standards (TS) 9308- 1.[1] Enterococci were enumerated according to the TS 7899-2[2] method. Varying levels of bacterial contamination were recorded in samples from these ten stations. It was observed that bacterial contamination was highest in the village of Burmagecit. Results indicate that microbiological contaminations were found to be above the allowable amount for drinking waters given by the World Health Organization (WHO). Because of this, appropriate disinfection methods and regular quality control mechanisms must be implemented by the Health Directorate of Tunceli.

Key words: Bacterial contamination, Drinking water, Tunceli.

The bacteriological contamination of drinking water is a major problem for public health in the developing world. The WHO estimates that, globally, about 1.1 billion people drink unsafe water and the vast majority of diarrheal disease in the world (88%) is attributable to unsafe water, sanitation, or hygiene.[3] The main source of microbiological contamination causing serious health problems is microorganisms from human or animal excreta, which returns through contaminated water from wastewater, landfills, or wastewater treatment stations.[4,5]

Detection of bacterial indicators in drinking water indicates the presence of pathogenic microorganisms that are likely to be the source of water-borne diseases. Such diseases could be potentially fatal.[6,7] Water-borne infections can occur when water contaminates dishes, fruits, vegetables, hands and equipment used during the preparation of some foods.[8] They can even be transmitted through aerosols.[9]

Frequent examination of fecal indicator microorganisms remains the most effective method of assessing the hygienic quality of water. Indicator organisms of fecal pollution include the coliform group as a whole and particularly *Escherichia coli*, *Streptococcus feacalis* and some thermo tolerant microorganisms such as *Clostridium perfringens.*[10] The most commonly used indicators for microbiological contamination are the coliforms: both total and fecal coliforms. *E. coli* is a subgroup of the coliform group.[11,12] Enterococci, members of the group fecal streptococci, are common components of normal flora of the intestinal tracts of all warm-blooded animals. They can enter streams or coastal waters through uncontrollable animal behavior, worsening bacteriological quality.[13,14]

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Knowing the importance of safe drinking water, water sources are routinely examined to ensure safety for drinking in developed countries.[15] The present study was carried out to determine the current status of the bacteriological quality of drinking water in different areas of Tunceli city.

MATERIALS AND METHODS

Collection of samples

The microbiological dataset from ten stations in Tunceli were obtained from the Health directorate of Tunceli for this study. *E. coli* and total coliform detection was found using the Membrane Filtration (MF) method[1] and *Enterococci* were enumerated according to ISO 7899-2.[2] Figure 1 shows the locations of these ten sampling stations.

General information about these sampling stations (population of the location, coordinates of sampling stations, whether there are extensive agricultural activities or livestock farming, and the current status of drinking water sources) is summarized in Table 1.

RESULTS AND DISCUSSION

The bacteriological quality of drinking water has attracted great attention worldwide because of known public health effects. Drinking water contaminated with animal and human feces is the major source of transmission of microbial pathogens to humans. Intermittent water supply, insufficient chlorination and sewage flooding seem to be associated with self-reported diseases. [16] The bacteriological quality of drinking water is primarily

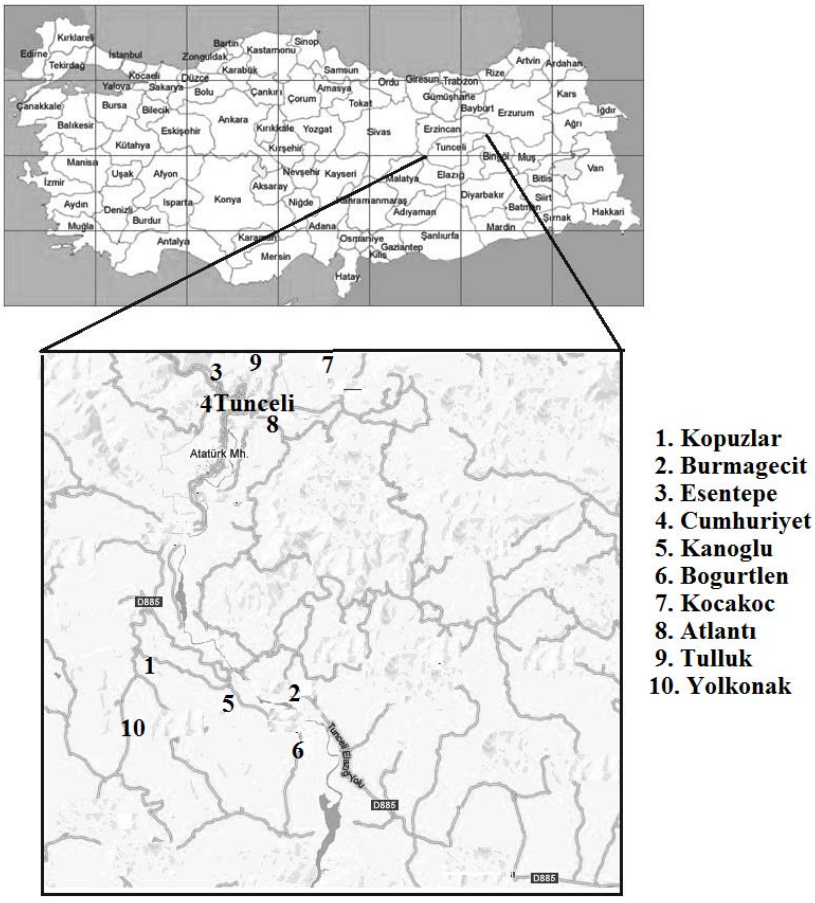

Fig. 1. Map of sampling locality

determined using "indicator organisms" whose presence indicates fecal contamination. The presence of the indicators is often key in assessing potential public health risks due to pathogens and is used in drinking water quality regulations and guidelines in many countries.[17] In this study, microbial indicators of fecal contamination such as Enterococci, total coliform and *E. coli* were recorded as CFU/100 mL. Table 2 shows microbiological contamination values found in the drinking water collected from the ten different stations of Tunceli.

The highest *E. coli* value (90 CFU/100 mL) and the highest total coliform levels were found in drinking water collected from station 2, while no *E. coli* and total coliform were detected in samples collected from station 4, 7, and 8. The reason for this high level of indicator bacteria in station 2 can be explained due to this station being in a rural area. Its population is higher compared to other rural locations sampled and there are extensive agricultural activities and livestock farming (Table 1). It was found that water from the village of Burmagecit is not appropriate for drinking. The continuous consumption of such contaminated water may pose serious health risks to local residents of this area. The Health Directorate of Tunceli also reported that people living near station 2 complained of digestive system disorders derived from drinking water. The highest *Enterococcus*

Table 1. Information about locations and water sources

S. No#	N*	AA**	LF***	Coordinates	Information about water sources
1	80	+	+	39.48995-38.99118	Drinking water, water supply network system (spring water)
2	479	+	+	39.53980-38.96566	Drinking water, water supply network system (spring water)
3	1850	-	-	39.55410-38.96566	Drinking water, water supply network system (spring water)
4	6500	-	-	39.53646-39.10465	Drinking water, water supply network system (spring water)
5	72	-	-	39.50762-38.99129	Drinking water, water supply network system (spring water)
6	153	+	+	39.58204-38.94542	Drinking water, no water supply network system (spring water-drinking fountain)
7	90	+	+	39.65844-39.11845	Drinking water, no water supply network system (spring water-drinking fountain)
8	36	+	+	39.60482-39.08558	Drinking water, no water supply network system (spring water-drinking fountain)
9	59	+	+	39.54835-39.16977	Drinking water, no water supply network system (spring water-drinking fountain)
10	102	+	+	39.48324-38.98077	Drinking water, water supply network system (spring water)

#ST. No: Station number, N*: Population, AA**: Locations of agricultural activities, LF***: Locations of livestock farming

Table 2. Microbiological contamination in drinking water samples collected from ten station of Tunceli

Microbiological indicators	Numbers of stations									
	1	2	3	4	5	6	7	8	9	10
Enterococcus (CFU/100 ml)	2	7	1	0	1	30	0	0	0	0
Total Coliform (CFU/100 ml)	7	>100	6	0	3	30	0	0	42	9
E. coli (CFU/100 ml)	7	90	0	0	3	3	0	0	3	0

value (30 CFU/100 mL*)* was found at station 6. There were also complaints to the Health Directorate of Tunceli from people living near this location. Enterococci were not detected in samples from stations 4, 7, 8, 9, and 10.

Yan and Sadowsky[18] found that fecal pollution of waterways may originate from wastewater treatment facilities, septic tanks, domestic and wild-animal feces, and pets. Also, direct access of livestock to canals in rural areas is an important source of potential pathogens in water sources. The presence of *E. coli* is an indication of fecal contamination and the highly probable presence of pathogens. The absence of *E. coli*, however, is no guarantee for the absence of these pathogens, as the retention and survival of *E. coli* and pathogens in many environments, e.g. drinking water distribution systems, is not adequate.[5,19] The coliform bacterial group occurring in water due to fecal contamination is associated with discharges of feces by humans and other animals reaching water sources. Coliform includes the members of the family Enterobacteriaceae, e.g. *E. coli, Enterobacter aerogenes,* Salmonella and Klebsiella.[20] Drinking water contaminated with coliform can cause stomach and intestinal illness including diarrhea and nausea, and could even lead to death. These effects may be more severe and possibly life threatening for babies, children, the elderly or people with immune deficiencies or other illnesses[21].

Yildirim *et al*.[5] evaluated microbiological contamination levels in drinking water samples collected from towns in Tunceli, Turkey. They found *E. coli*, total coliform and enterococci in drinking water samples collected from towns of Tunceli, but microbiological contaminations were found below the allowable amounts for drinking water provided by the WHO. Results indicate that microbiological contaminations were found above the allowable amounts for drinking water given by the WHO at stations 1, 2, 3, 5, 6, 9 and 10.[22] Drinking water at these stations is not appropriate for human consumption.

CONCLUSION

Bacterial contamination of drinking water generally exceeded the WHO limits in the sampling areas of Tunceli, Turkey. Keeping in view the high level of contamination of drinking water in some areas of Tunceli, it is essential that water be examined regularly and frequently throughout the year as contamination may be intermittent. At the same time, there is a need for making the water supplies safe for human use by regular chlorination and taking immediate measures whenever contamination is observed. [15] Appropriate disinfection methods and regular quality control mechanisms have been applied by the Health Directorate of Tunceli.

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